An Analysis of a Technological Intervention - GPS Tracking system to Monitor the Discarded Scrapped Vehicles

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Abstract

End-of-life vehicles (ELVs), as a significant second form of resources, have enormous benefits for both the environment and economy. ELV technological intervention is a growing area that has received attention in the past few decades due to the explosive expansion of ELVs. GPS tracking system is one of the technological intervention tools which track the movement of discarded scraped vehicles (ELVs). End-of-life vehicles management can benefit greatly from the use of GPS tracking to track the movements of discarded vehicles. In this study identified five parameters. VIKOR methodology employed to select the best parameter amongst the five parameters.

Keywords: Waste management, ELV, GPS monitoring, VIKOR

1. INTRODUCTION

The efficient as well as very cautious treatment of discarded vehicles is of utmost significance throughout the arena of discarded vehicles or end-of-life vehicle (ELV) management. Integrating technological advances has changed the game because of rising environmental concerns and the necessity of adhering to extremely stringent law [1]. ELV technological intervention is a growing area that has received attention in the past few decades due to the explosive expansion of ELVs [2]. GPS tracking system is one of the technological intervention tools which track the movement of discarded scraped vehicles (ELVs). End-of-life vehicles management can benefit greatly from the use of GPS tracking to track the movements of discarded vehicles [3]. The employing of GPS (Global Positioning System) tracking for monitoring the movement of discarded vehicles is an example of technological intervention that offers a number of advantages that strengthen the overall ELV handling procedure. GPS monitoring systems are becoming steadily increasing in popularity among ELV and recycling facilities as an instrument to guarantee for safe and secure economical as well as appropriate handling of scrapped automobiles [4]. The aforementioned systems employing GPS tracking devices which have been implanted within the end-of-life vehicles to provide real time position and movement information. Through the application of specialized software, the information that is obtained from these sensors is then analyzed and processed to provide important details regarding the location and condition of end-of-life vehicles [5].

Numerous benefits might be obtained through the application of GPS tracking for end-of-life vehicles. Improves of security protocol, decreasing the possibility of stealing or unauthorized transportation, and ensuring that ELVs are handled in a way that complies with environmental rules are all benefits of this [6]. Furthermore, this technology helps optimize the logistics and transportation of discarded scrap vehicles, with the outcome in considerable cost saving, decreased consumption of fuel, along with increased operational efficiency [7]. This GPS monitoring system advances beyond simple position tracking by including data analytics, helping ELV facilities to make trustworthy, and data driven decisions for further planning. ELV management can enhance the way they function, significantly reduce their negative environmental impact, and verify compliance with laws and regulations along with the use of information regarding transportation pattern and movements [8].

Moreover, GPS tracking devices provided crucial assistance to first responders in circumstances of accidents or fires involving ELV vehicles. The information gathered has the potential to be extremely helpful in evaluating environmental effects, which ensures correct disposal, and optimizing the entire range of ELV management system [9]. When using GPS monitoring systems, it is crucial to take care of privacy and data security concerns, since the device accumulates sensitive data. One of the most important challenges for ELV management is finding an appropriate balance between utilizing the advantages of GPS tracking and protecting privacy [10].

The development of GPS tracking for monitoring the movement of discarded scrap vehicles serves as a significant advancement in the environment friendly and accountable ELV management in India. ELV facilities can optimize their productivity [4], comply with environmental regulations, and assure the secure, effective management of discarded scrap vehicles by utilizing the power of real-time data and location monitoring, along with lowering costs and enhancing overall sustainability [11].

2. IDENTIFICATION OF PARAMETERS

GPS tracking could serve as an effective instrument for managing end-of-life vehicles (ELVs), there are a number of parameters and obstacles difficulties that involved with its application.

a) Cost of Equipment

The cost of equipment is a significant parameter to deploying GPS monitoring to follow the movement of discarded scraped vehicles in end-of-life vehicle (ELV) management [7]. To determine the possible financial advantages and efficiency enhancements provided on GPS monitoring, accomplish thorough cost benefit analysis. To support the expenditure, emphasis the saving from theft prevention, increased effectiveness and decreased operating expenses [12].

b) Limited battery life

Usually GPS tracking equipment in ELVs function on battery power. Long-term tracking can quickly drain batteries, necessitating regular replacements or recharges. Select GPS tracking systems that include energy saving features [13]. Look for gadgets that consume less power and can run continuously on a single battery charge. Implementing a battery management strategy that involves regular battery life monitoring. For assured continuous tracing, replace, recharge batteries beforehand. Where appropriate, think about using rechargeable batteries to cut expenses over a longer period of time [14].

c) Maintenance

In end-of-life vehicles (ELVs) management, maintenance is crucial component of upholding GPS tracking systems for observing the movement of scrapped vehicles [15]. To get beyond this obstacle, it is essential to make sure that the GPS tracking devices and related equipment are properly maintained. The cost of operating GPS monitoring systems is increased by the regular maintenance [11], which includes battery replacement and software upgrades. Establish and put into practice an arrangement for GPS tracking device maintenance. To examine, service and replace components as necessary, establish a regular maintenance programme [16].

d) Data privacy and security

Installing GPS tracking devices for monitoring the movement of discarded scraped vehicles in end-of-life vehicle (ELV) management necessitates the highest consideration of data privacy and security issues [17] [18]. It is crucial to safeguard sensitive tracking data and make sure that data privacy laws are followed. Make sure that all data is secured using robust encryption algorithms before it is delivered between GPS tracking devices and central computers. This blocks anyone from seeing the data while it is being sent [8].

e) Integration of existing system

For efficient operation and data administration, it is essential to integrate a GPS tracking system for monitoring the movement of scrapped vehicles with an existing End-of-life (ELV) management system [19]. Start by performing a thorough evaluation of current ELV management system. Acknowledge its functionality, data types, and architecture. Determine the areas where integrating GPS tracking data might improve operations [20].

3. RESEARCH METHODOLOGY

Various alternatives are typically evaluated and compared for sustainability using the multiple criteria decision (MCDM) techniques, such as Visekriterijuska Optimizacija l Komoromisno Resenje (VIKOR), with the objective of providing assistance in making decision for choosing the important resilient and appropriate possibilities [21]. The recommended complete formulation of VIKOR may be implemented to rank and select the best parameter for the GPS tracking system to monitor the ELV movement after establishing the GPS tracking system characteristics and developing a selected set of parameters in a specific application.

4. RESULT AND DISCUSSION

The Opricovic initially presented the VIKOR approach in 1998 to address multi criteria decision making (MCDM) challenges and find the optimum acceptable option. When there are competing factors, this strategy focuses on ranking and choosing from a group of choices [22]. The VIKOR method's major goal is to select the solution that comes the most closely to meeting each criterion's perfect level, so that the alternatives are based on their respective degrees of closeness to the optimum answer [23].

In this study there are 4 criteria and 5 alternatives that are ranked based on VIKOR method. The table below shows the type of criterion and weight assigned to each criterion.

Table: 1 Characteristics of Criteria

	name	type	weight
1	cost	Positive	0.25
2	relaibility	Positive	0.25
3	feasibility	Positive	0.25
4	accuracy	Positive	0.25

The following table shows the decision matrix.

Table: 2 Decision Matrix

	cost	relaibility	feasibility	accuracy
Cost of equipment	5	3	4	2
Limited battery life	2	4	3	4
Maintenance	5	2	4	3
Data Privacy and security	4	5	4	3
Integration of existing systems	3	2	5	4

The VIKOR method involves the following steps:

The Steps of the VIKOR Method

STEP 1: Normalize the decision matrix

The following formula can be used to normalize.

$$f_{ij}(\mathrm{x}) = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad i = 1, \ldots, m \;\; ; j = 1, \ldots \;\; , n$$

The table below shows the normalized decision matrix.

Table: 3 Normalized Decision Matrix

	cost	relaibility	feasibility	accuracy
Cost of equipment	0.563	0.394	0.442	0.272
Limited battery life	0.225	0.525	0.331	0.544
Maintenance	0.563	0.263	0.442	0.408
Data Privacy and security	0.45	0.657	0.442	0.408
Integration of existing systems	0.338	0.263	0.552	0.544

STEP 2: Determine the best f_i^* and worst f_i^- benefits of each criterion

The best and worse benefits can be determined by the following formula:

If the criterion is positive, then

$$f_j^* = Max_i f_{ij} \;\; , \;\; f_j^- = Min_i f_{ij} \quad ; \quad j = 1,2, \ldots, n$$

If the criterion is negative, then

$$f_j^* = Min_i f_{ij} \;\; , \;\; f_j^- = Max_i f_{ij} \quad ; \quad j = 1,2, \ldots, n$$

The positive ideal solution (f^{*}) and negative ideal solution (f^{-}) can be expressed as follows:

$$f^{*} = \{f_1^{*}, f_2^{*}, f_3^{*}, \dots, f_n^{*}\}$$

$$f^{-} = \{f_1^{-}, f_2^{-}, f_3^{-}, \dots, f_n^{-}\}$$

STEP 3: Calculate the S_i and R_i values

The values S_i and R_i , representing the group utility and individual regret, respectively, can be calculated by the formulas below :

$$S_i = \sum_{j=1}^{n} w_j \frac{(f_j^{*} - f_{ij})}{(f_j^{*} - f_j^{-})}$$

$$R_i = Max_j \left[w_j \frac{(f_j^{*} - f_{ij})}{(f_j^{*} - f_j^{-})} \right]$$

Where w_j denotes the weight of the criteria.

The following table shows the values S_i and R_i .

Table: 4 The values S and R

	R	S
Cost of equipment	0.25	0.542
Limited battery life	0.25	0.583
Maintenance	0.25	0.5
Data Privacy and security	0.125	0.333
Integration of existing systems	0.25	0.417

STEP4: Calculate the value Q_i

The value Q_i , representing the VIKOR index for each alternative can be calculated by the following formula:

$$Q_i = \gamma \frac{(S_i - S^{*})}{(S^{-} - S^{*})} + (1-\gamma) \frac{(R_i - R^{*})}{(R^{-} - R^{*})}$$

Where

$$S^{*} = Min_i\{S_i\} \;;\; S^{-} = Max_i\{S_i\} \;;\; R^{*} = Min_i\{R_i\} \;;\; R^{-} = Max_i\{R_i\}$$

And γ is the maximum group utility represented by value 0.8.

Table: 5 The values Q

	Q
Cost of equipment	0.867
Limited battery life	1
Maintenance	0.733
Data Privacy and security	0
Integration of existing systems	0.467

STEP5: Rank the alternatives, sorting by the S, R and Q values

Alternatives are ranked by sorting the S, R, and Q, values in decreasing order such that the best rank is assigned to the alternative with the smallest VIKOR value. The results are three ranking lists.

The following table presents the ranking list for the alternatives based on the S, R, and Q values

Table: 6 The ranking list for the alternatives

	R value	Rank in R	S value	Rank in S	Q value	Rank in Q
Cost of equipment	0.25	2	0.542	4	0.867	4
Limited battery life	0.25	2	0.583	5	1	5
Maintenance	0.25	2	0.5	3	0.733	3
Data Privacy and security	0.125	1	0.333	1	0	1
Integration of existing systems	0.25	2	0.417	2	0.467	2

STEP 6: Propose a compromise solution

The alternative ($A^{(1)}$), which is the best ranked by the measure Q (minimum) if the following two conditions are satisfied:

Condition 1. Acceptable advantage: $Q(A^{(2)}) - Q(A^{(1)}) \geq 1/(m-1)$ where $A^{(1)}$ is the alternative with first position and $A^{(2)}$ is the alternative with second position in the ranking list by Q. m is number of alternatives.

Condition 2. Acceptable stability in decision making: The alternative $A^{(1)}$ must also be the best ranked by S or/and R.

If one of the conditions is not satisfied, then a set of compromise solutions is proposed, which consists of:

Solution 1. Alternatives $A^{(1)}, A^{(2)}, \ldots, A^{(M)}$ if Condition 1 is not satisfied; Alternative $A^{(M)}$ is determined by $Q(A^{(M)}) - Q(A^{(1)}) < 1/(m-1)$ for maximum M (the positions of these alternatives are ‘‘in closeness’’).

Solution 2. Alternatives $A^{(1)}$ and $A^{(2)}$ if only condition 2 is not satisfied.

Solution 3. Alternative with the minimum Q value will be selected as the best Alternative if both conditions are satisfied.

result of the conditions survey is shown in the following table.

Table: 7 result of the conditions survey

Condition 1	Acceptance
Condition 2	Acceptance
Selected solution	Solution 3

Therefore, Data Privacy and security is selected as the final alternative.

5. CONCLUSION

The entire globe focuses a lot of careful consideration to the environment, resources, energy, and vehicle recovery has the potential to play a vital role in these areas. This research offered an improved version of the VIKOR approach based on an innovative normalization methodology that depends on the goal assessment criteria and therefore generates a very thorough algorithm with emphasis on compromise solution in scrapped and discarded vehicles. We suggested an innovative and practical GPS tracking system that is appropriate for India’s current state of development and is capable of providing assistance to other emerging nations.

6. REFERENCES

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